

# MEMORANDUM

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**To:** Klamath Fishery Management Council  
**From:** Klamath River Technical Advisory Team  
**Date:** 30 August 2001  
**Subject:** Review of: CDFG, 16 Aug 2001, "An Inseason Recreational Chinook Harvest Predictor For the Klamath River Basin".

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On 24 August 2001, the Klamath River Technical Advisory Team (Team) reviewed a document titled "An In-season Recreational Chinook Harvest Predictor for the Klamath River Basin." The document was prepared by the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service on 16 August 2001. The model developed in the subject document was in response to an historically large predicted run size of Klamath Basin fall chinook anticipated for 2001 and uncertainties as to whether the river recreational fishery could realize the allocated harvest. Due to constraints on ocean fisheries, a greater than average share of the non-tribal harvest has been allocated to the river recreational fishery resulting in an allocation of 29,800 adult fall chinook. Since 1978, the largest Klamath River Basin recreational harvest on record was 22,203 adults, occurring in 1988.

Given the available data, the authors selected a ratio estimator that compared the recreational total basin harvest to the harvest in the lower Klamath River (below Coon Creek) during the first five weeks of the fishery (statistical weeks 31–35). The data used were years 1989 through 1999; data from 1997 was excluded due to the fact that a unusually

high proportion of the basin-wide harvest occurred in the river mouth.

The Team expressed concerns about the quality of the data available for the predictor. For example, the lower river harvest may have historically included spring chinook. Prior to 1998, CDFG biologists did not apportion the harvest by race (spring/fall chinook). In addition, as pointed out in the document, some of the apparent correlation between total basin harvest and that realized in the lower river during the first five weeks, is due to the fact that in most years the lower river harvest was used to estimate the upper Klamath River harvest. The document also notes that the data set contains years in which fishery harvest was constrained by quotas, along with years in which quotas were not constraining.

Another issue discussed by the Team was how changes in regulations during the 1989-1999 period might effect the derived relationship and its validity to the 2001 management year. In particular, 2001 regulations provide for a three-fish bag-limit rather than the customary one- or two-fish bag limit. Using data derived from a variety of regulation profiles may affect the accuracy of the proposed estimator for total basin harvest.

Recognizing these data limitations, the Team concurred that the ratio estimator approach developed in the document is a reasonable way to obtain a point estimate of total recreational harvest for 2001; however, the Team was concerned that the sampling variance of this point estimator may be large. The Team thus discussed the possibility of extending the timeframe of the lower river predictor variable beyond week 35 (Sept 2), recognizing that for the estimator to be useful for management purposes, it should not extend too much beyond that date. The Team then reviewed the entire dataset, which included the lower river harvest by week (weeks 31–41) and the total basin harvest for years 1989–2000, inclusive,

and noted that a substantial portion of the lower river catch usually occurred in week 36; thus its inclusion in the predictor variable should reduce the estimator's sampling variance.

The Team examined the effect of including week 36 in the predictor model, and to fit the model using only data in those years not substantially restricted by quotas (1989, 1990, 1996, 1999). The Team also felt it important to attach a measure of uncertainty to the point estimator and developed a prediction interval approach for this purpose which is presented below. These prediction intervals should be considered approximate, but they do attempt to account for errors of estimation in the ratio (slope) and process variation about the conditional mean (line). The intervals were derived assuming that the ratio model holds, and that process variation is itself proportional to the predictor variable (increases with  $x$ ).

For the week 31–35 model, the point estimate for 2001 is obtained by multiplying the lower river harvest over this period by 7 (Figure 1, slope of dotted line). The approximate 0.95-level prediction interval upper bound is similarly obtained by multiplying the week 31–35 lower river harvest by 10 (Figure 1, solid upper line). For the week 31–36 model (Figure 2), the predictions are similarly obtained using multipliers of 3.5 and 6, respectively. The Team feels confident that the week 31–36 model is the better of the two, and that the total basin harvest is unlikely to exceed that estimated by the week 31–36 prediction interval upper bound.

The Team appreciates the opportunity to review and provide input on the development of an inseason predictor for the 2001 river recreational harvest.

## Statistical basis of the prediction interval.

The data model is

$$y = \beta x + \epsilon, \quad V(\epsilon) = \sigma^2 x, \quad (1)$$

for which the ratio estimator gives

$$\hat{\beta} = \bar{y}/\bar{x}, \quad \text{and} \quad \hat{y} = \hat{\beta}x. \quad (2)$$

The sampling variance of  $\hat{\beta}$  is estimated as

$$\hat{V}(\hat{\beta}) = \frac{1}{\bar{x}^2 n} \frac{\sum_{i=1}^n (y_i - \hat{y}_i)^2}{n-1}, \quad (3)$$

and the process variation is estimated as

$$\hat{V}(y|x, \hat{\beta}) = \frac{\sum_{i=1}^n (y_i - \hat{y}_i)^2 / x_i}{n-1}. \quad (4)$$

The prediction variance associated with forecasting a single additional data point (year 2001) is obtained by combining the two sources of variation:

$$\hat{V}_p(y|x, \hat{\beta}) = \hat{V}(\hat{\beta})x^2 + \hat{V}(y|x, \hat{\beta})x \quad (5)$$

For the prediction interval, apply the t-distribution quantile for the desired  $1-\alpha$  level (e.g. 0.95) and degrees of freedom  $n-1 = 4-1 = 3$  (yields a  $\sqrt{\hat{V}_p}$  multiplier of 3.2), giving an upper prediction bound ( $\hat{y}_U$ ) of

$$\begin{aligned} \hat{y}_U|x &\approx \hat{y} + t_{df} \sqrt{\hat{V}_p(y|x, \hat{\beta})} \\ &= \left( \hat{\beta} + 3.2 \sqrt{\hat{V}(\hat{\beta}) + \hat{V}(y|x, \hat{\beta})/x} \right) x. \end{aligned} \quad (6)$$

